Spore Size Comparison Between Several Bacillus Species

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Introduction

• GOALS - Better understand properties of simulants vs. agents. Provide data to help choose appropriate simulants and surrogates for specific tasks.

• METHOD - Compare properties of simulants to those of the agents.

• FACILITY
  - Microbiology Team BSL3 Laboratory

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Properties (Non-Medical)

- Spore Size – length, width, aspect ratio
- Spore Density
- Effect of decon agents
- Fluorescence spectra
- Effect of UV radiation

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Spore Size

- Important to design and development of samplers and detectors

- Published spore sizes - spores produced under different conditions for each species without extensive comparisons, size distributions or ranges.

- Systematic comparison of the size of *B.anthracis* spores to size of other Bacillus spores (simulants/surrogates) - all spores produced under the same conditions.

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Methods

- Prepared spores of *B.anthracis* and other Bacillus species, including some common simulants/surrogates.

- Spores were fixed, negatively stained and imaged by TEM.

- Measurements of 100 spores (length, width, aspect ratio).

- Produced distributions.

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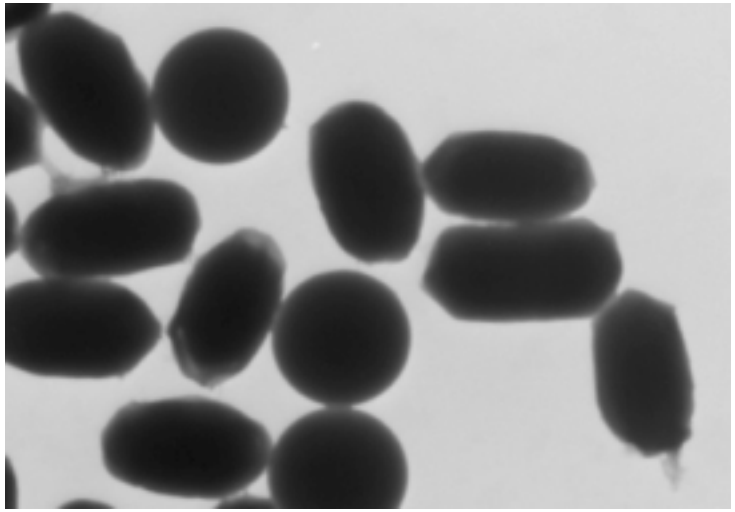
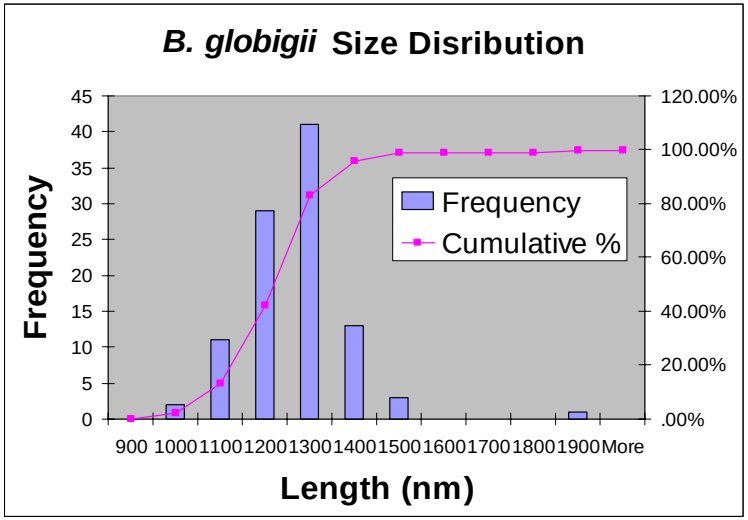
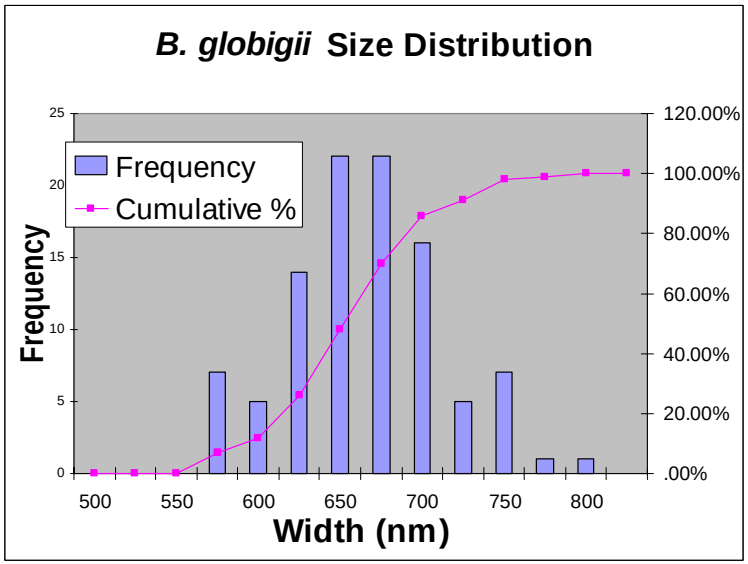
B. globigii SB512 *(B. atrophaeus)*





- **Length**
  - **Mean 1.22±0.12 µm**
  - **Range 0.91-1.90 µm**
- **Width**
  - **Mean 0.65±0.05 µm**
  - **Range 0.56-0.80 µm**



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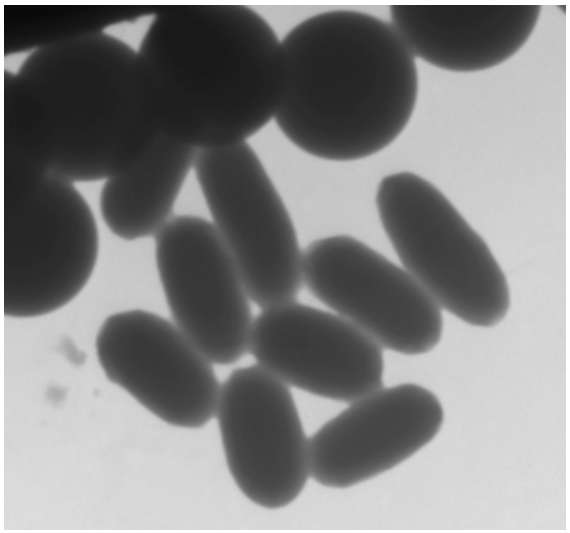
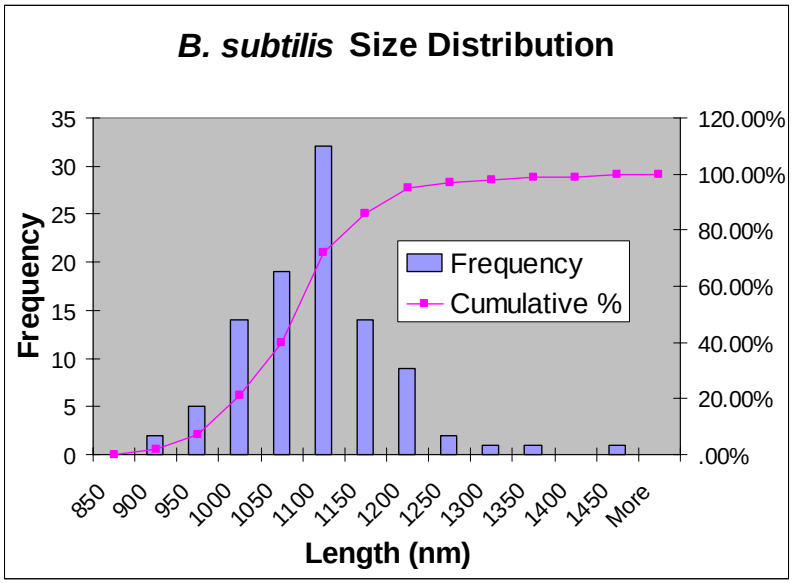
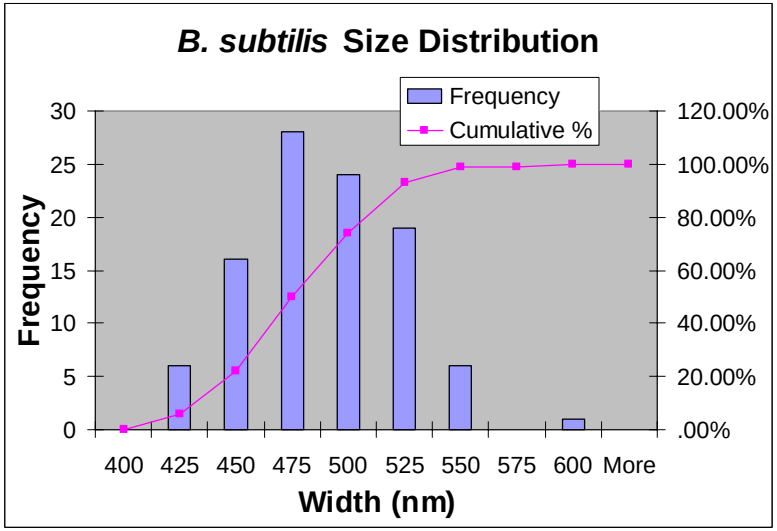
B. subtilis 1031

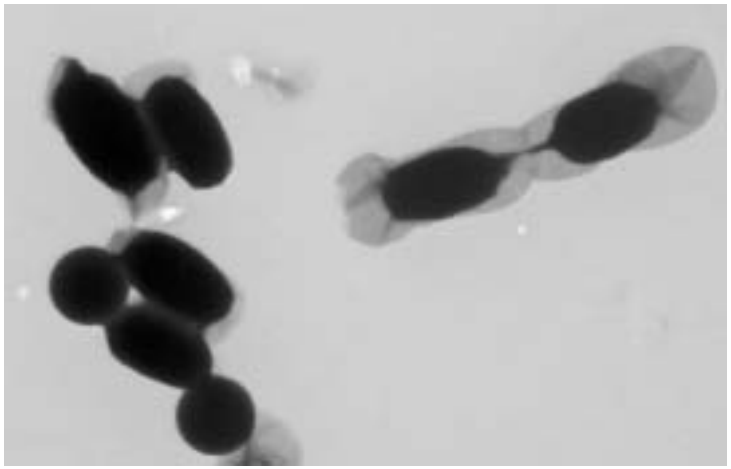


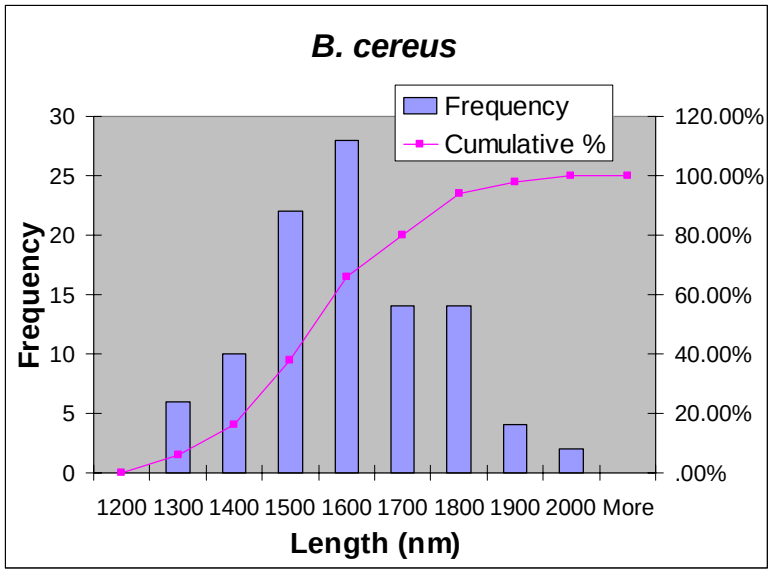


- **Length**
  - **Mean 1.07±0.09 μm**
  - **Range 0.87-1.41 μm**
- **Width**
  - **Mean 0.48±0.03 μm**
  - **Range 0.41-0.58 μm**

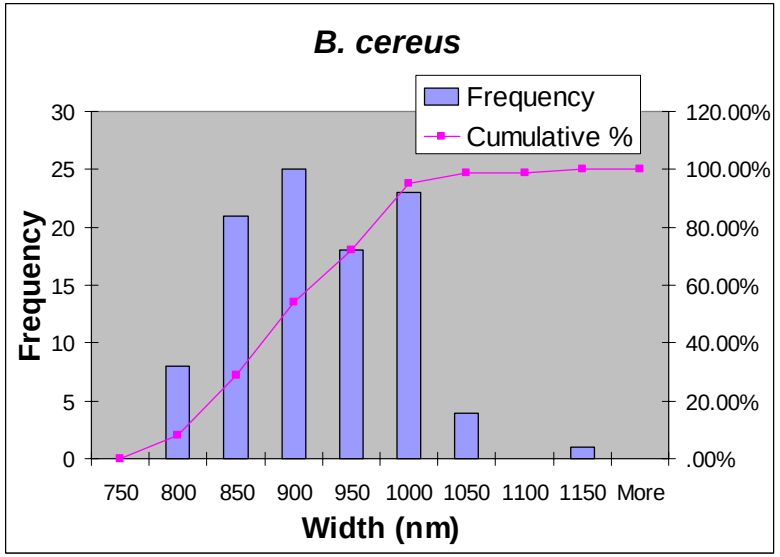


B. cereus ATCC 10702

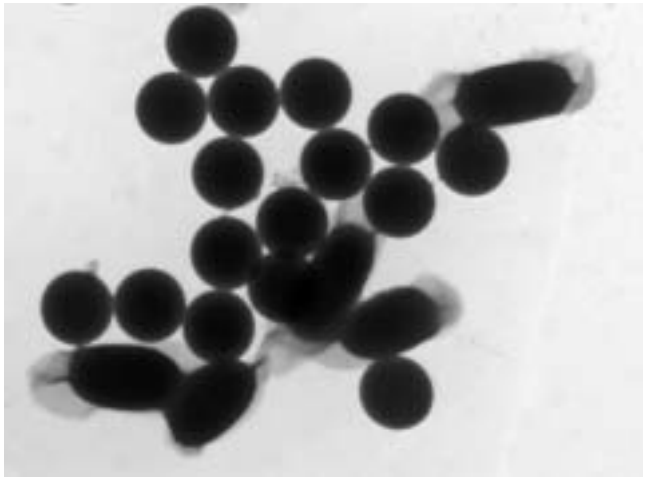


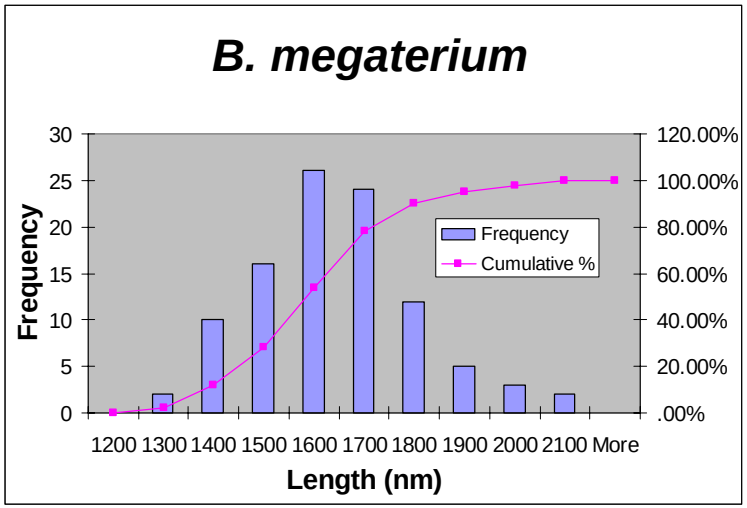


- **Length**
  - **Mean 1.55±0.16 µm**
  - **Range 1.21-2.00 µm**
- **Width**
  - **Mean 0.90±0.07 µm**
  - **Range 0.76-1.14 µm**

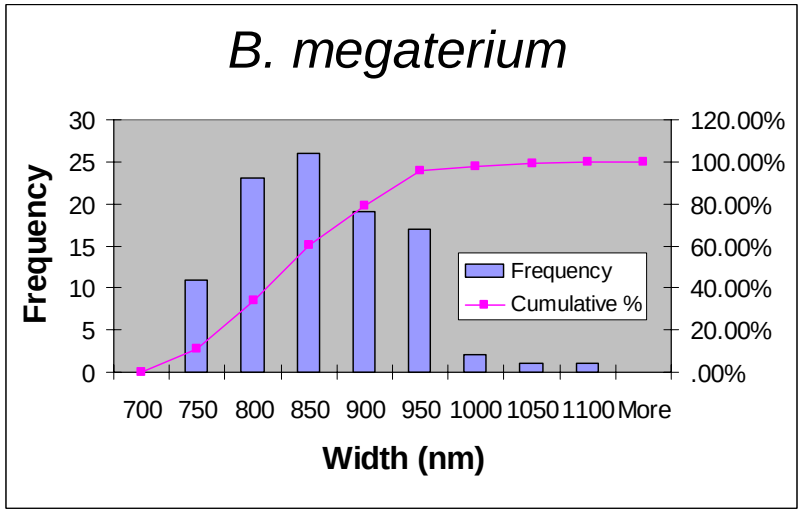


B. megaterium WW-15-4900





- **Length**
  - **Mean 1.60±0.16 µm**
  - **Range 1.28-2.04 µm**
- **Width**
  - **Mean 0.84±0.07 µm**
  - **Range 0.70-1.05 µm**



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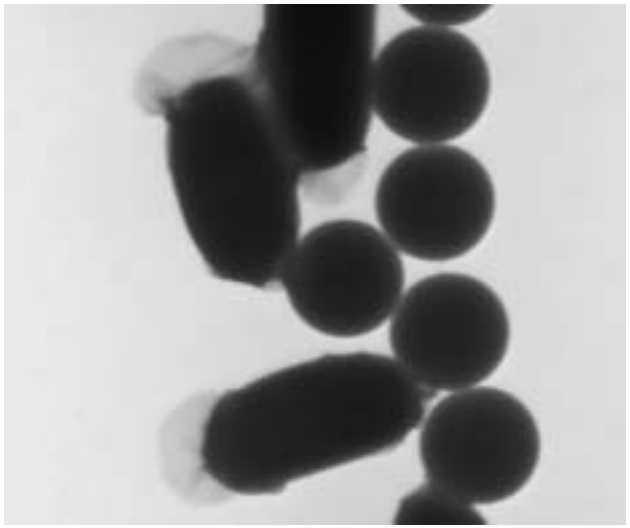
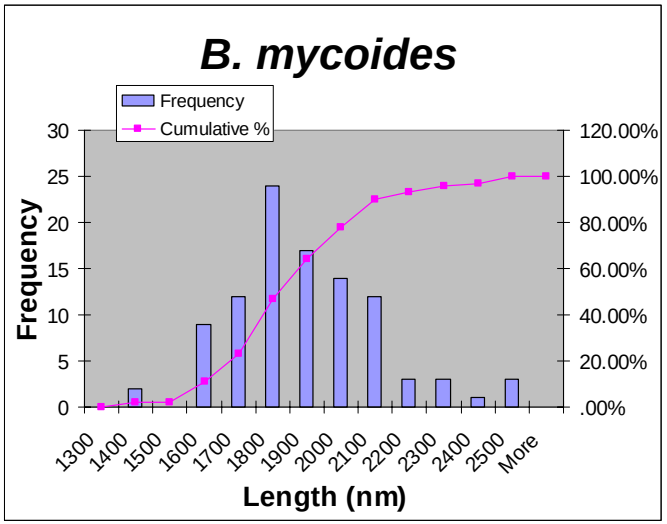
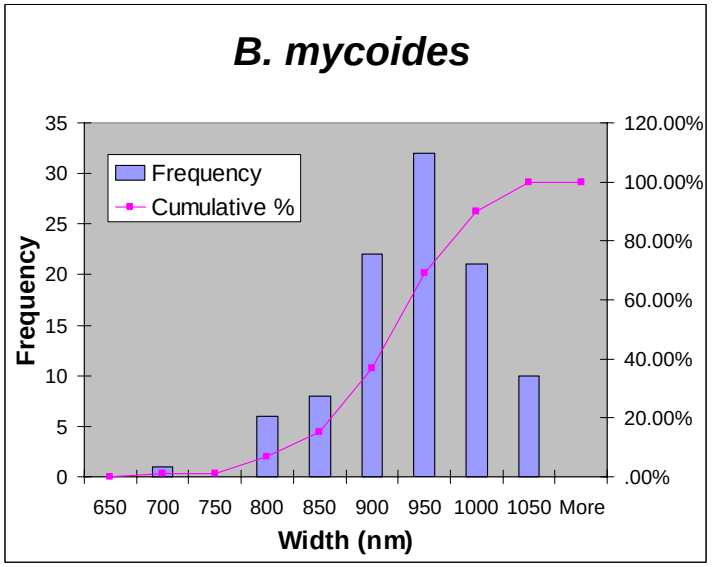
B. mycoides ATCC 10206





- **Length**
  - **Mean 1.85±0.21 µm**
  - **Range 1.33-2.44 µm**
- **Width**
  - **Mean 0.91±0.07 µm**
  - **Range 0.65-1.04 µm**



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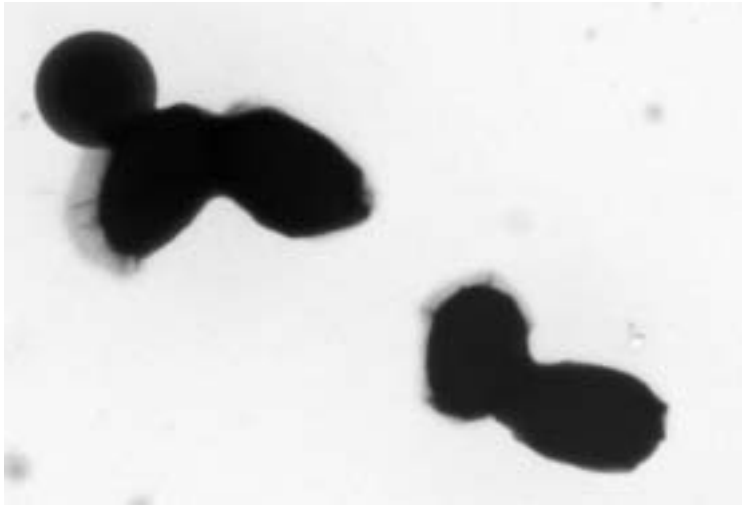
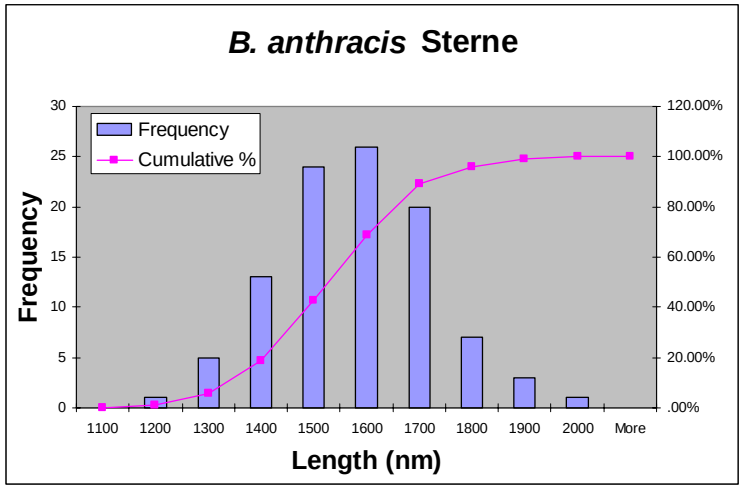
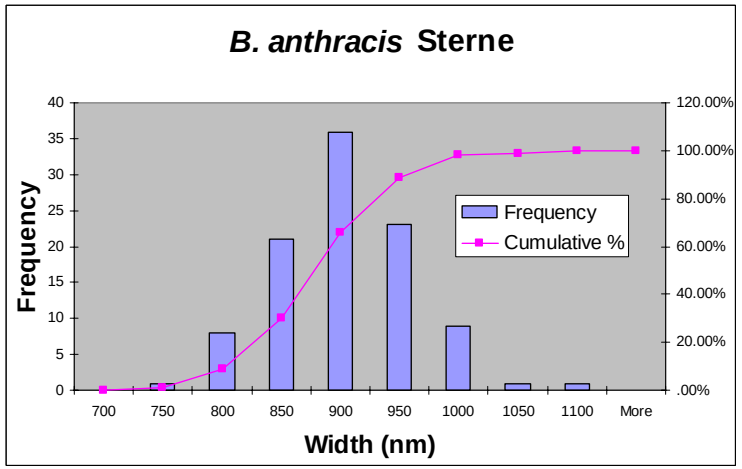
B. anthracis (Sterne)





- **Length**
  - **Mean 1.53±0.15 µm**
  - **Range 1.19-1.92 µm**
- **Width**
  - **Mean 0.88±0.06 µm**
  - **Range 0.71-1.09 µm**



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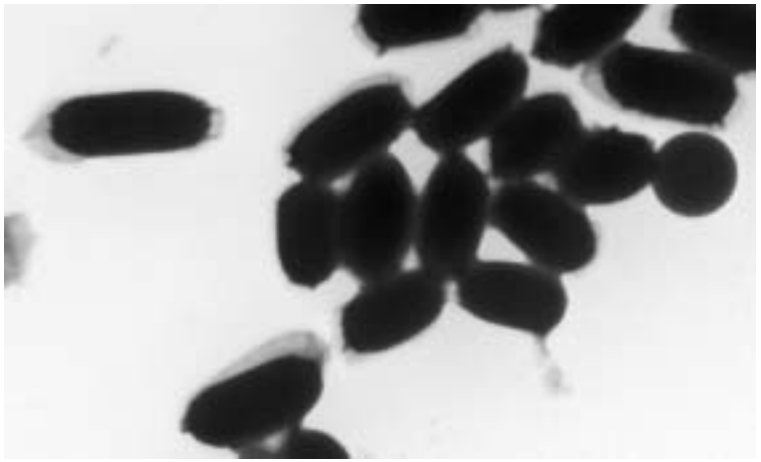
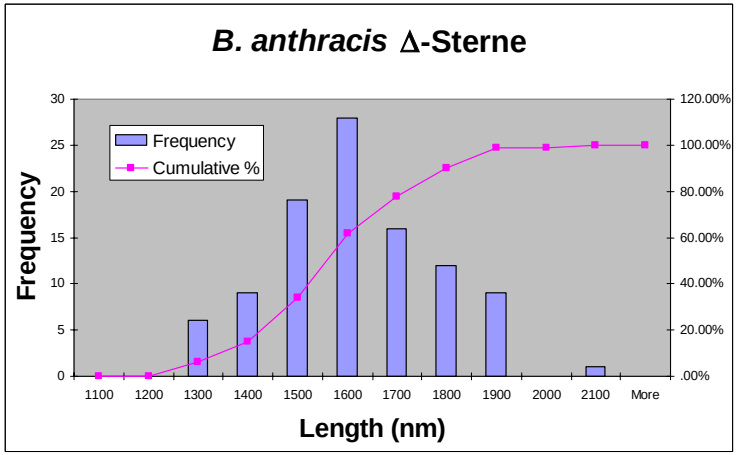
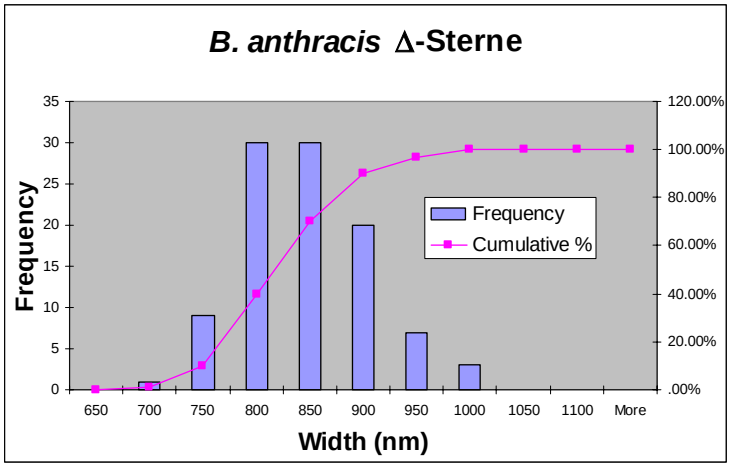
B. anthracis (Δ-Sterne)





- **Length**
  - **Mean 1.56±0.16 µm**
  - **Range 1.23-2.05 µm**
- **Width**
  - **Mean 0.82±0.06 µm**
  - **Range 0.68-0.98 µm**



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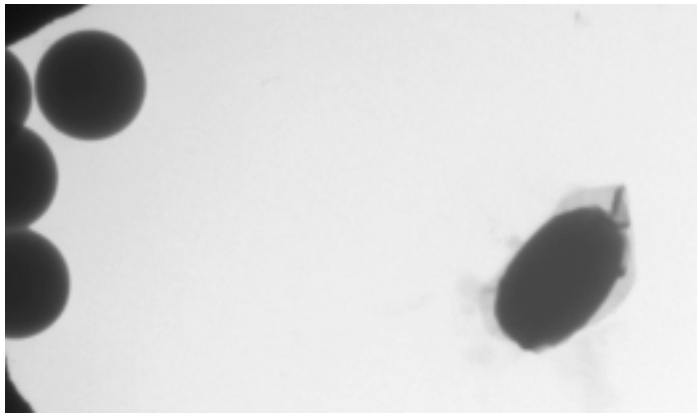
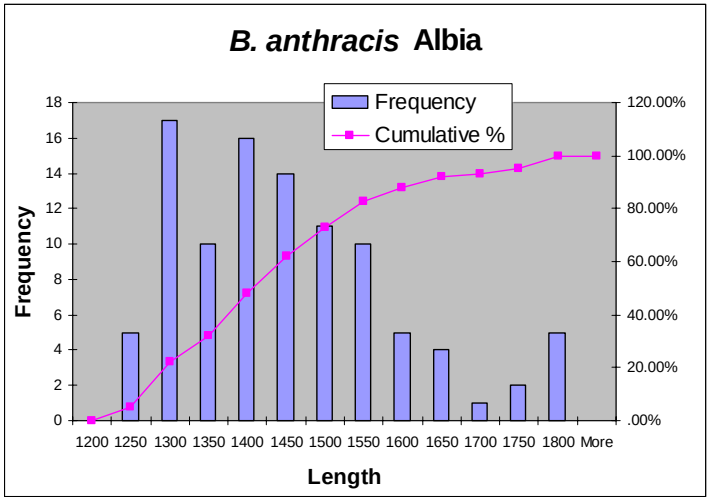
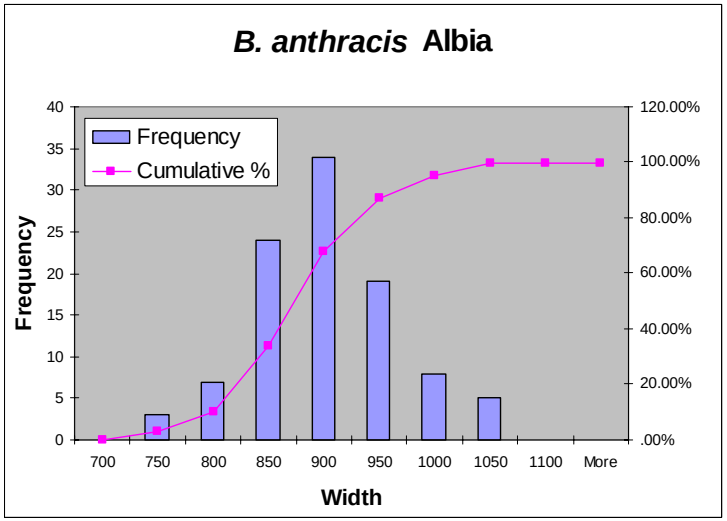
B. anthracis (Albia)





- **Length**
  - **Mean 1.43±0.14 µm**
  - **Range 1.22-1.79 µm**
- **Width**
  - **Mean 0.87±0.07 µm**
  - **Range 0.71-1.03 µm**



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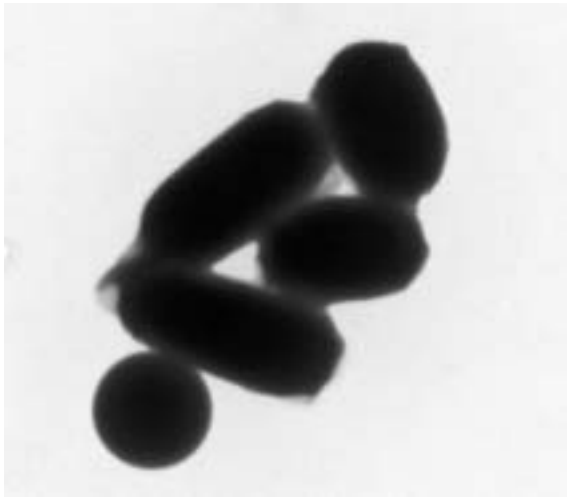
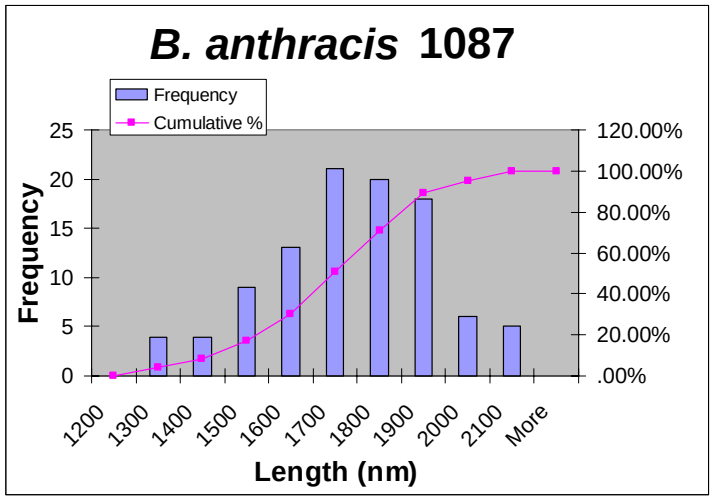
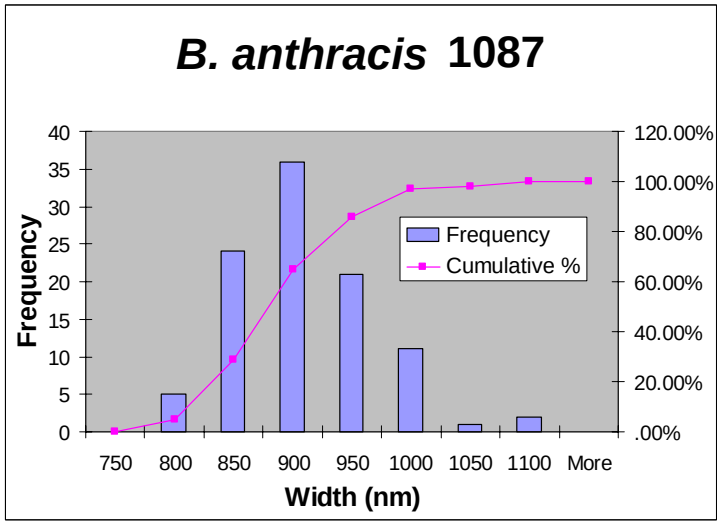
B. anthracis (NCTC 1087)





- **Length**
  - **Mean 1.68±0.19 μm**
  - **Range 1.23-2.08 μm**
- **Width**
  - **Mean 0.89±0.06 μm**
  - **Range 0.76-1.09 μm**



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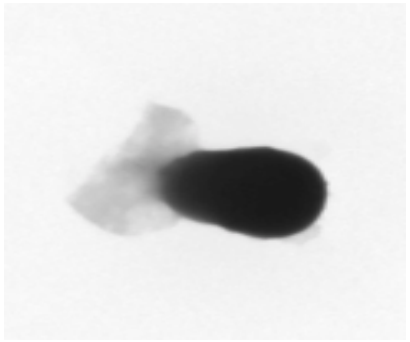
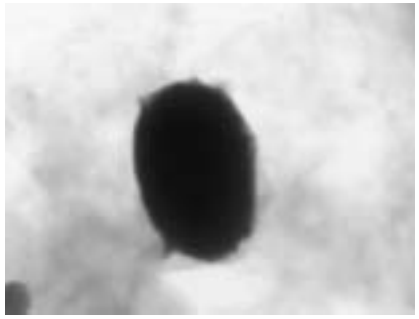
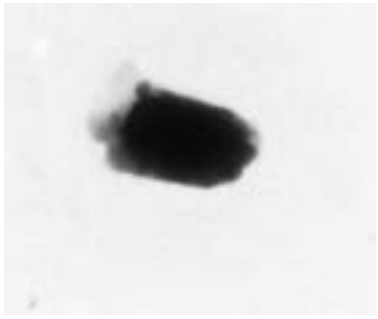
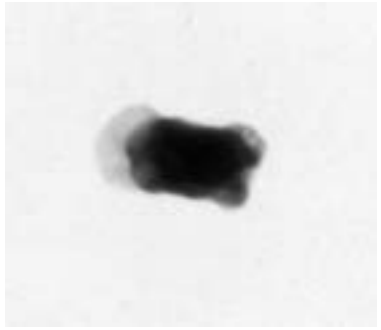
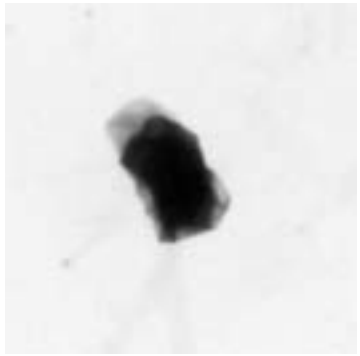
B. anthracis (NCTC 1928)


B. anthracis (LA1)

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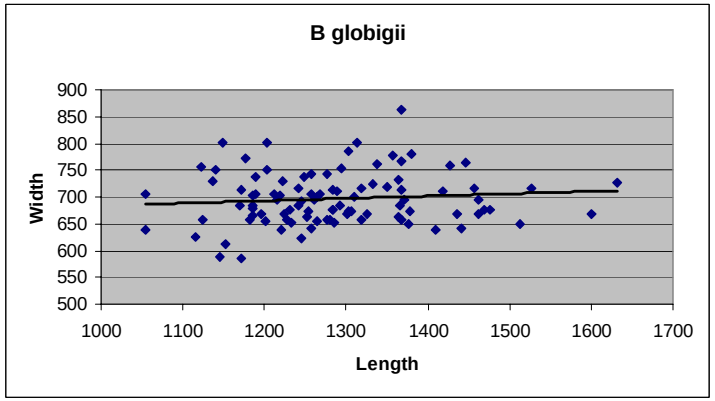
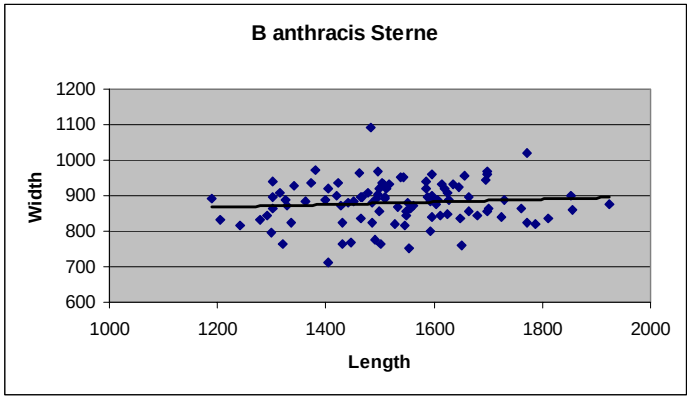
Aspect Ratio (L/W) of Bacillus spores



B. globigii

Mean 1.85 +/- 0.19

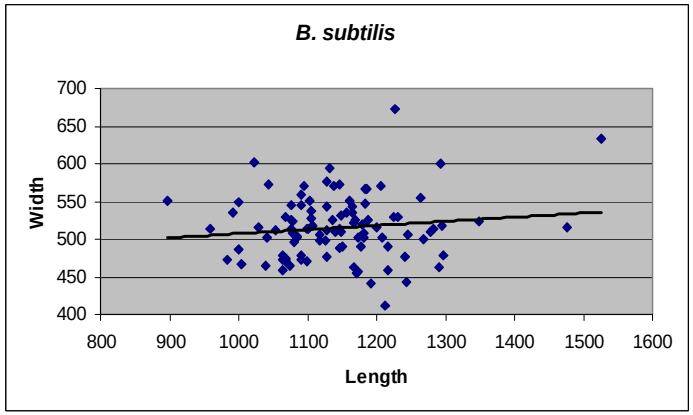
Range 1.43-2.39



B. a. Sterne

Mean 1.75 +/- 0.20

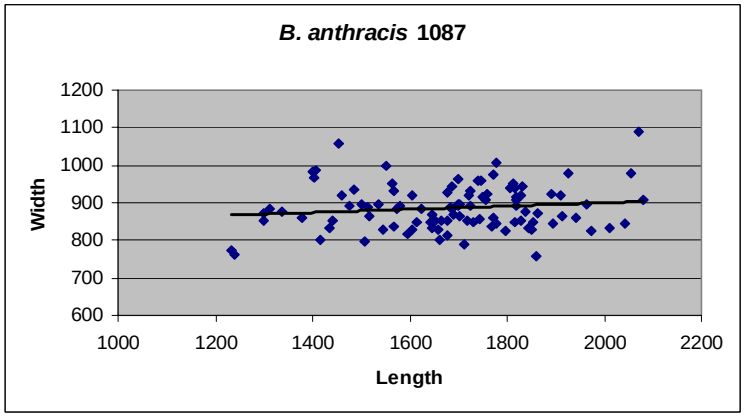
Range 1.33-2.20



B. subtilis

Mean 2.23 +/- 0.25

Range 1.63-2.95



B. a. NCTC 1087

Mean 1.91 +/- 0.23

Range 1.37-2.45

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Comparison of *B. anthracis* with other *Bacillus* species

	Length (µm)	Width (µm)
B. anthracis Albia	1.43 +/- 0.14	0.87 +/- 0.07
B. anthracis 1087	1.68 +/- 0.19	0.89 +/- 0.06
B. anthracis Sterne	1.53 +/- 0.15	0.88 +/- 0.06
B. anthracis D-Sterne	1.56 +/- 0.16	0.82 +/- 0.06
B. globigii	1.22 +/- 0.12	0.65 +/- 0.05
B. subtilis	1.07 +/- 0.09	0.48 +/- 0.03
B. cereus	1.55 +/- 0.16	0.90 +/- 0.07
B. megaterium	1.60 +/- 0.16	0.84 +/- 0.07
B. mycoides	1.85 +/- 0.21	0.91 +/- 0.07

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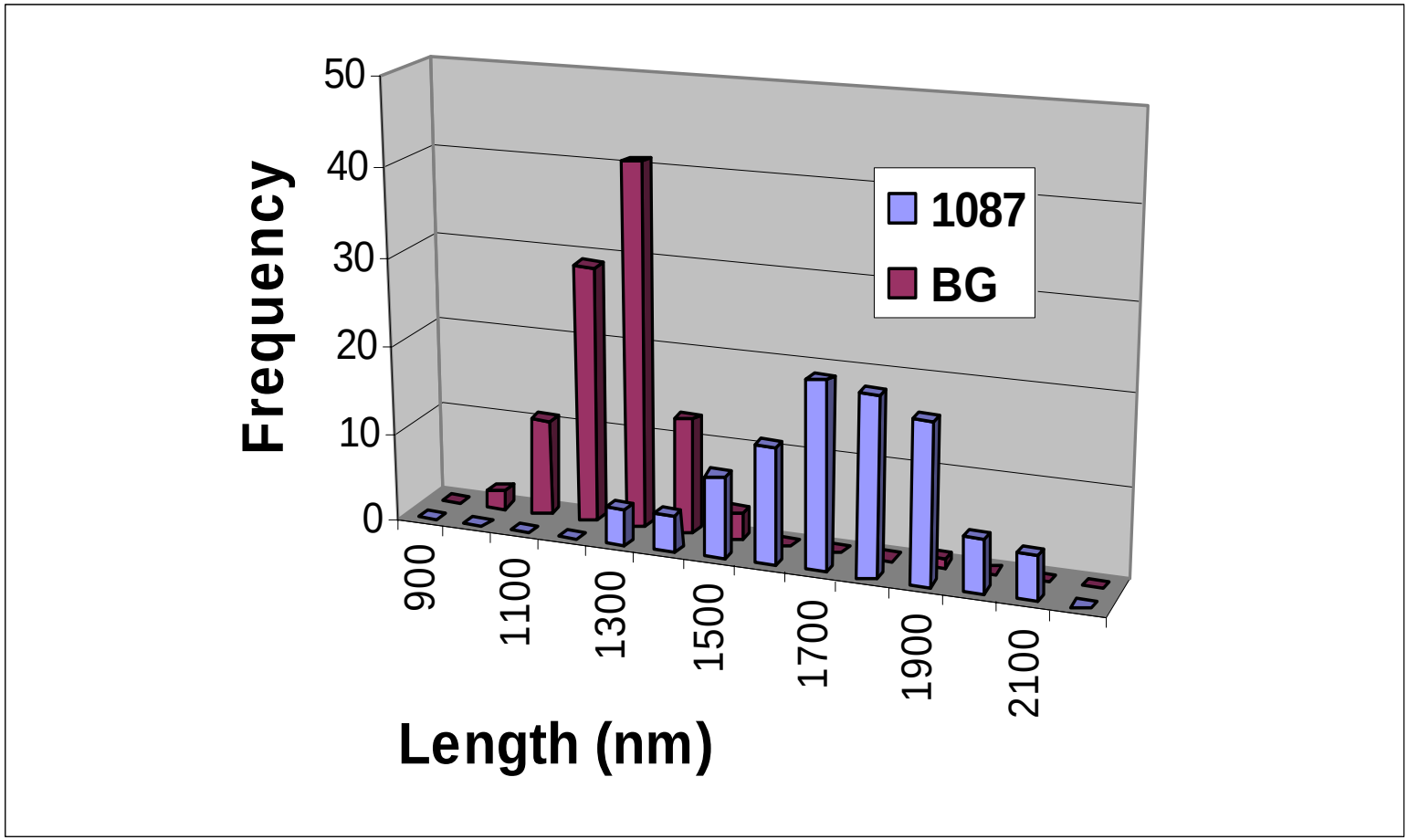
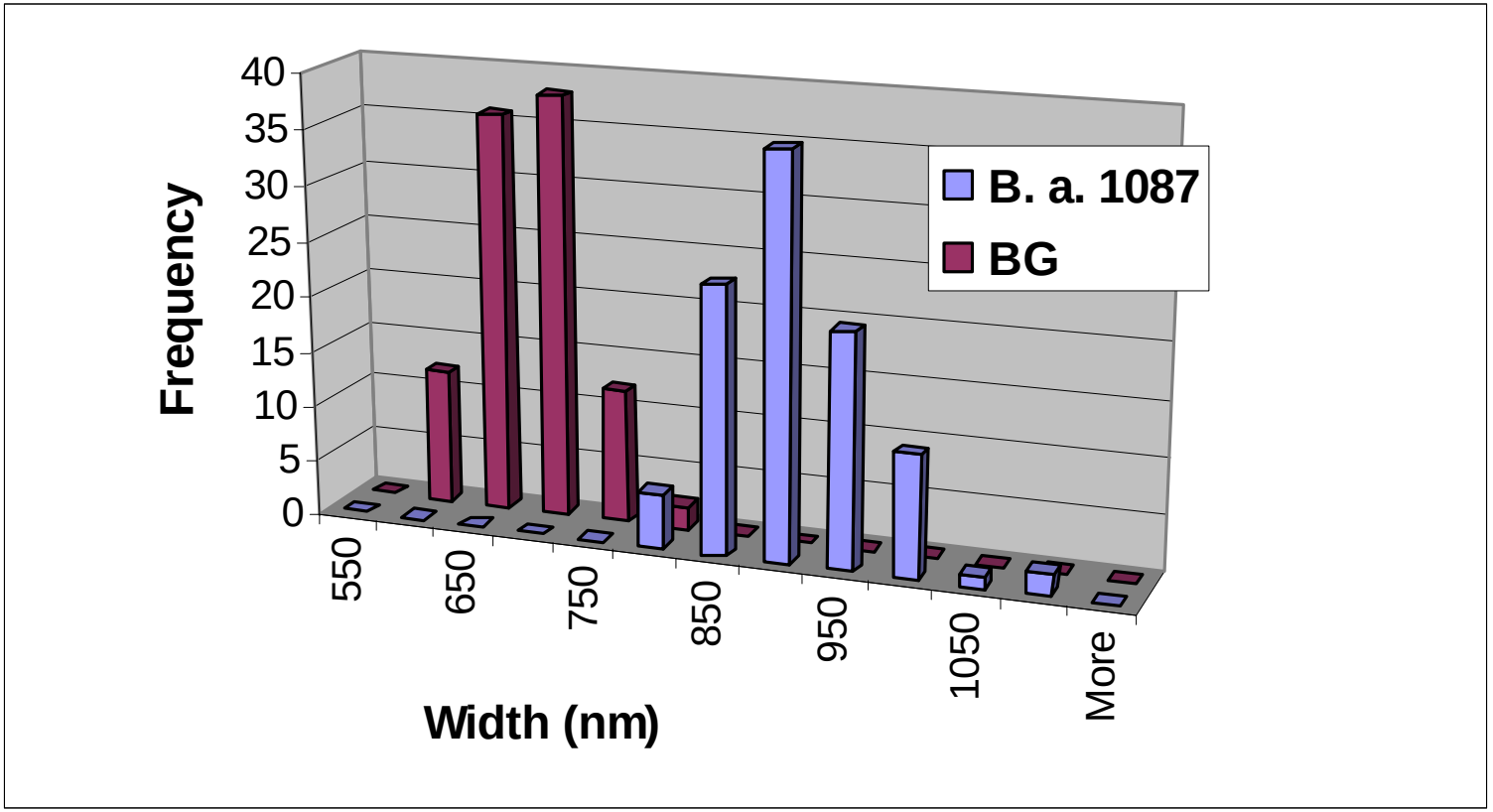
B.a. 1087 vs. B. g. (Length)



ECBC

B.a. 1087 vs. B. g. (Width)



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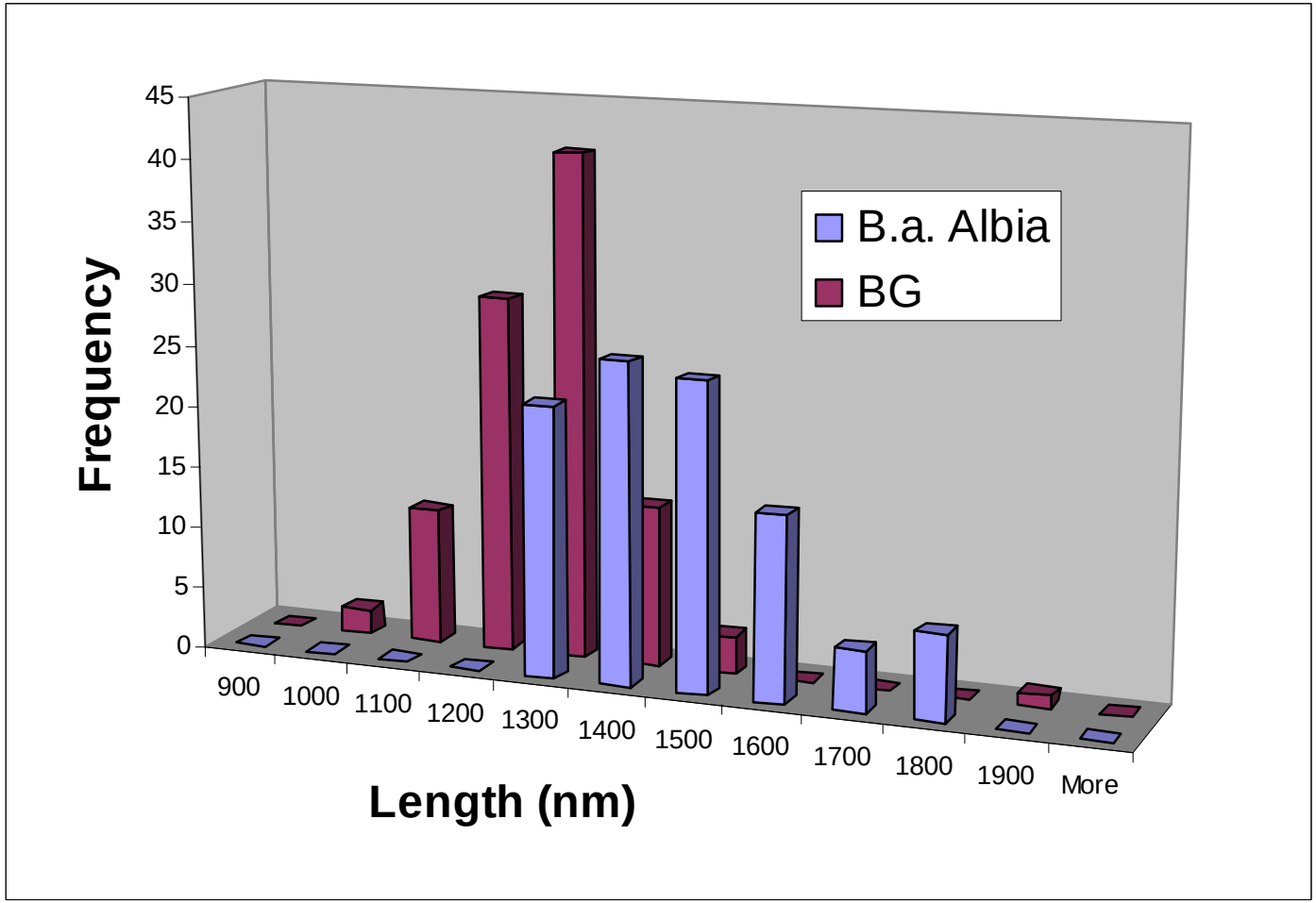
B.a. Albia vs. B. g. (Length)



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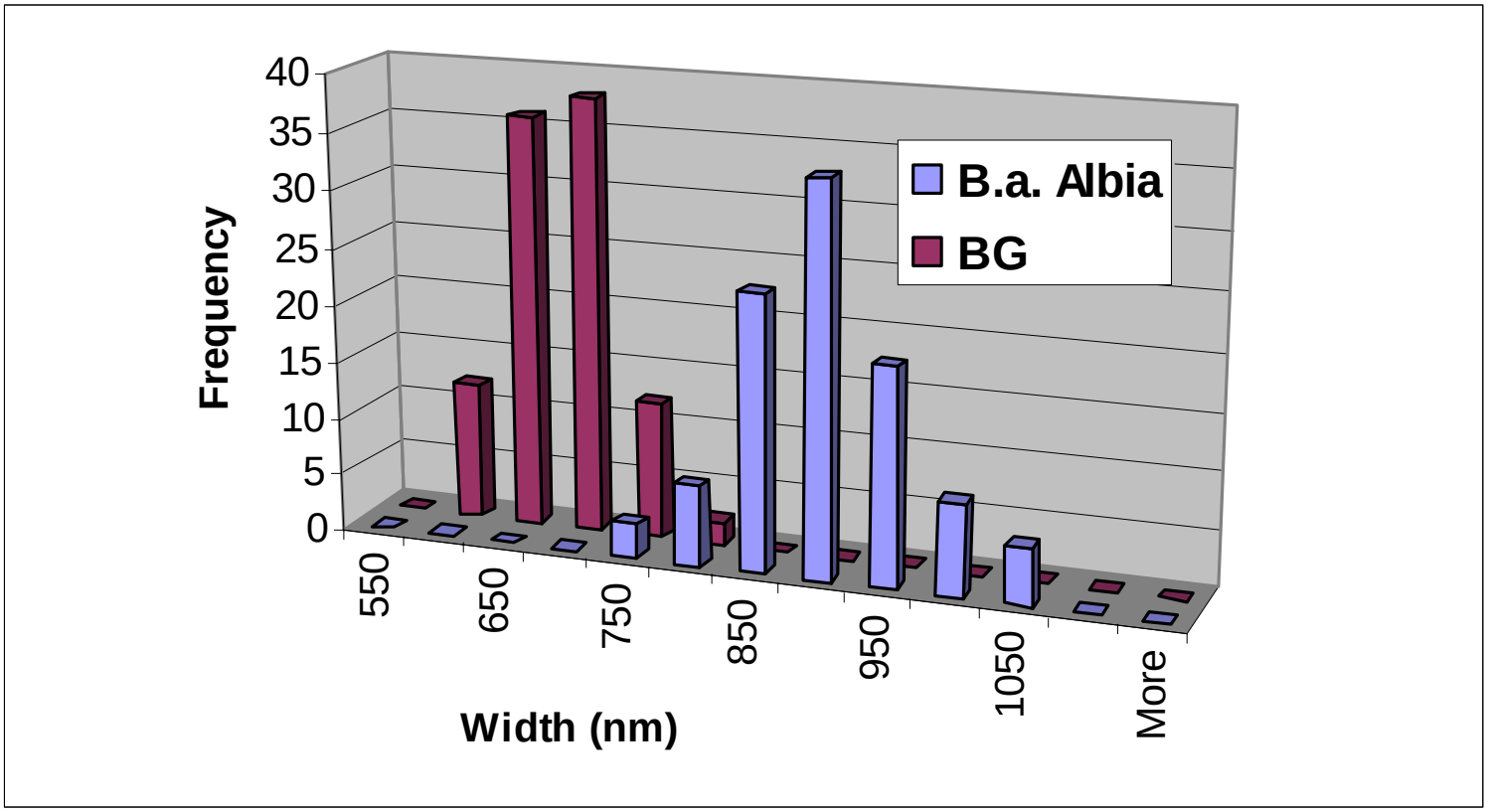
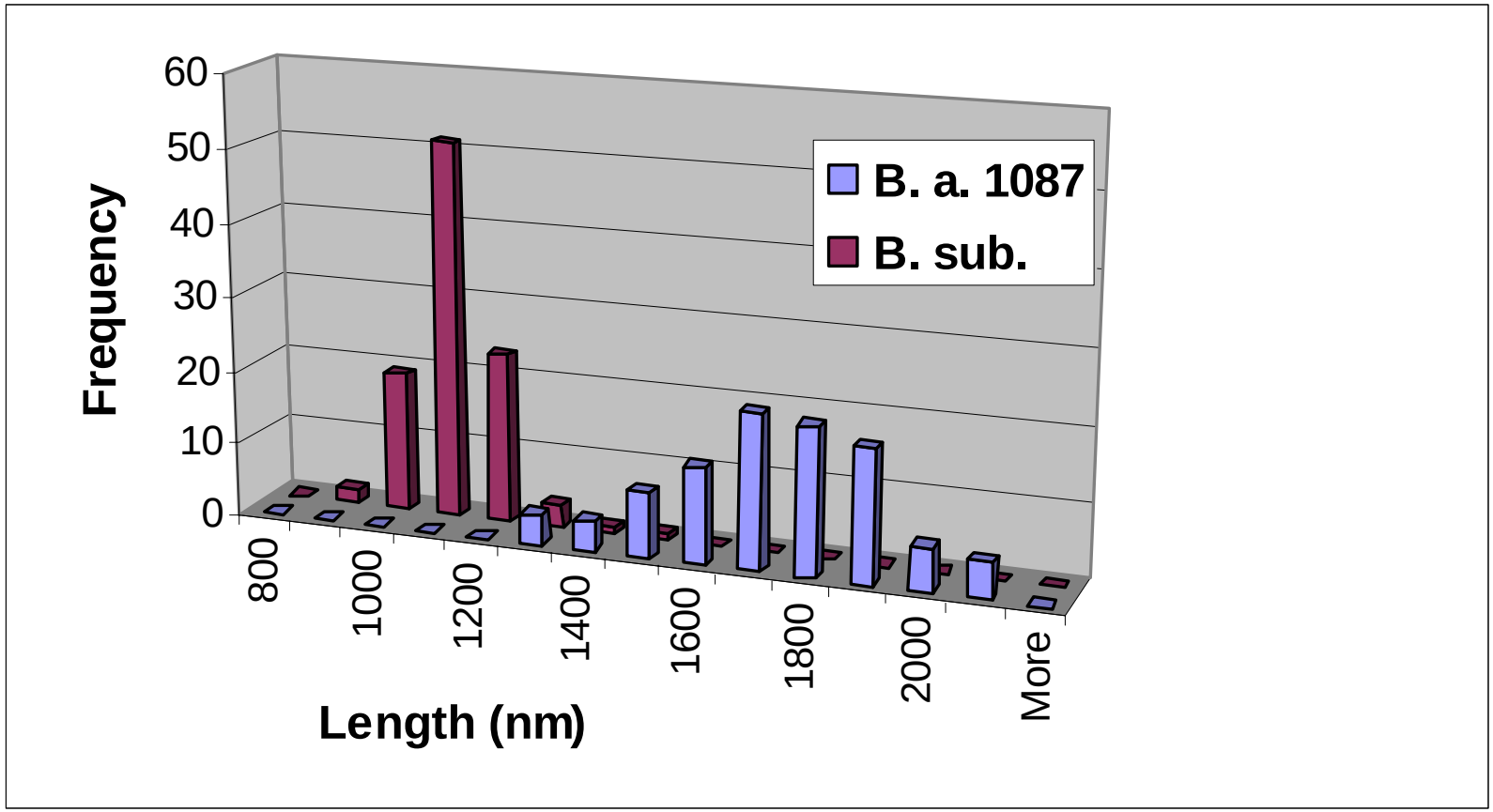
B.a. Albia vs. B. g. (Width)



B.a. 1087 vs. *B. subtilis* (Length)



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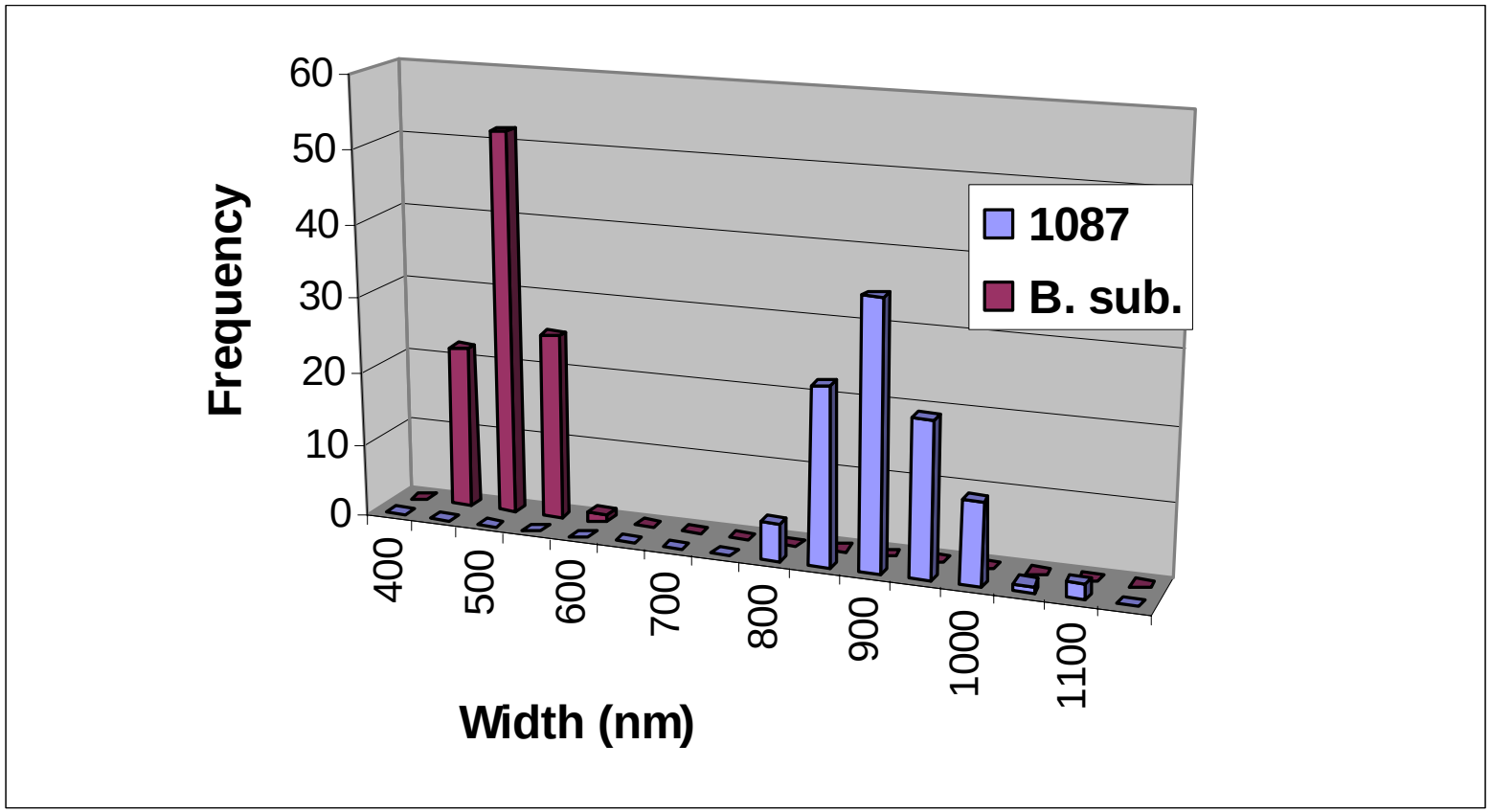
B.a. 1087 vs. *B. subtilis* (Width)



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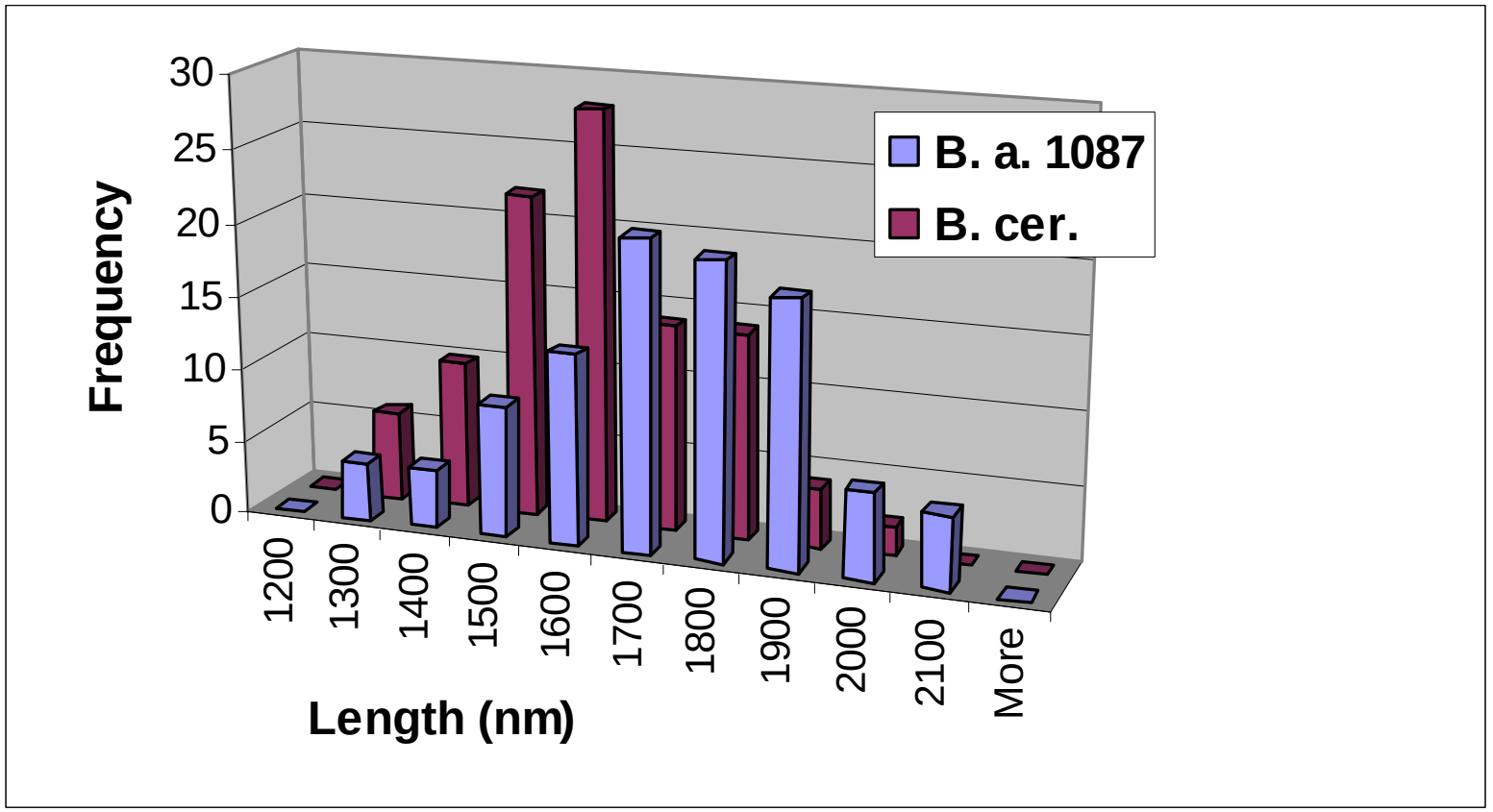
B.a. 1087 vs. *B. cereus* (Length)



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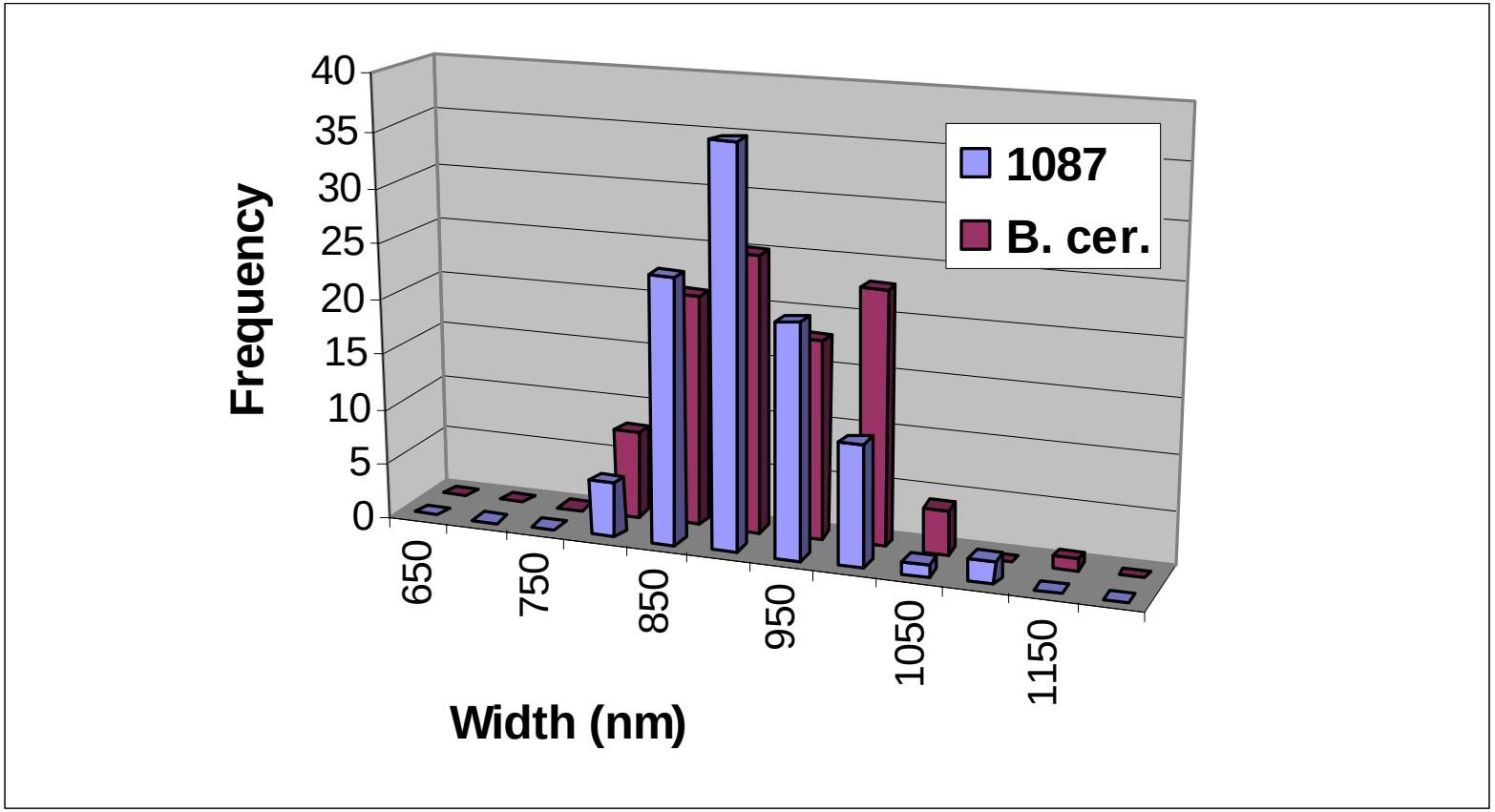
B.a. 1087 vs. *B. cereus* (Width)



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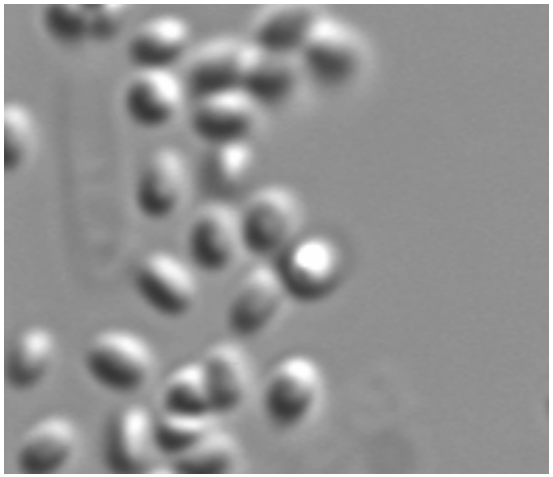
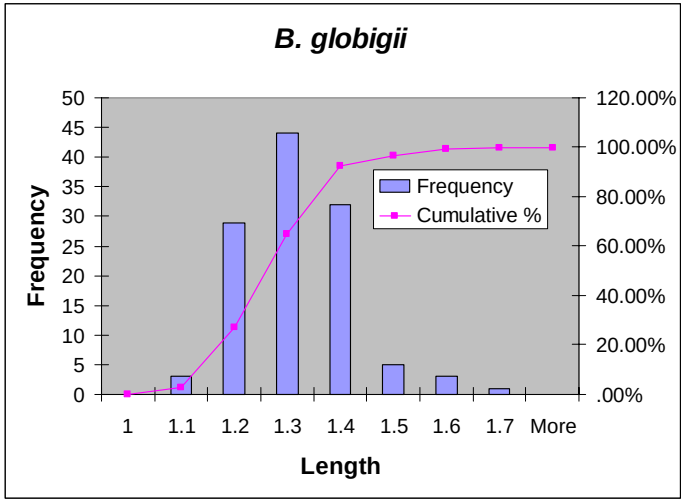
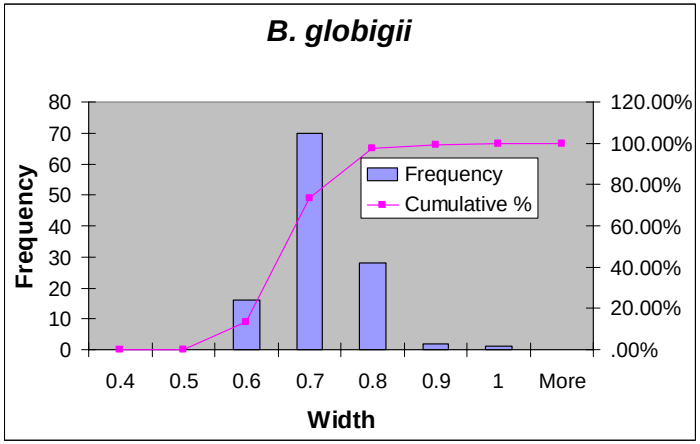
B. globigii SB512 *(B. atrophaeus)*





- **Length**
  - **Mean 1.27±0.10 µm**
  - **Range 1.04-1.61 µm**
- **Width**
  - **Mean 0.67±0.07 µm**
  - **Range 0.50-0.94 µm**



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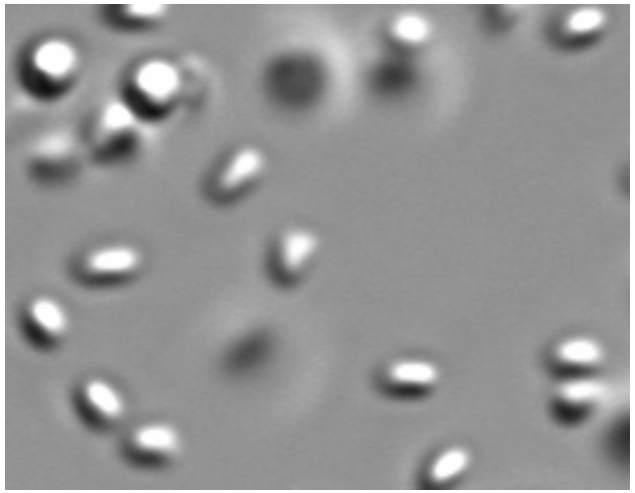
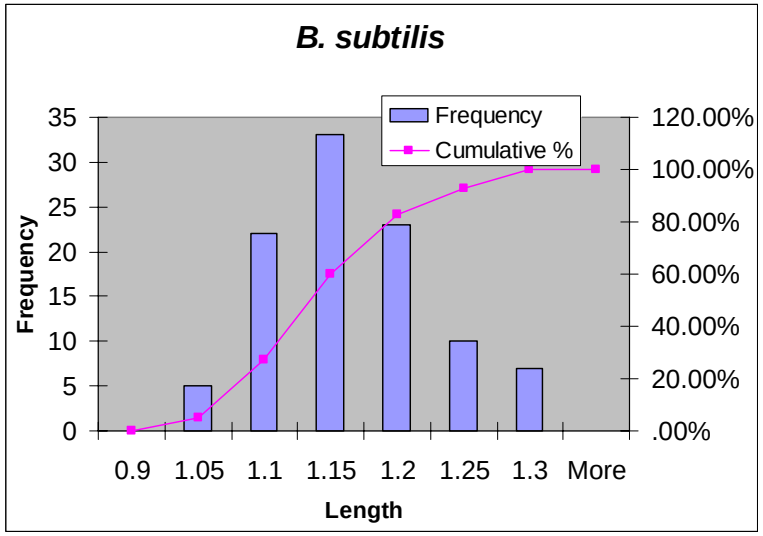
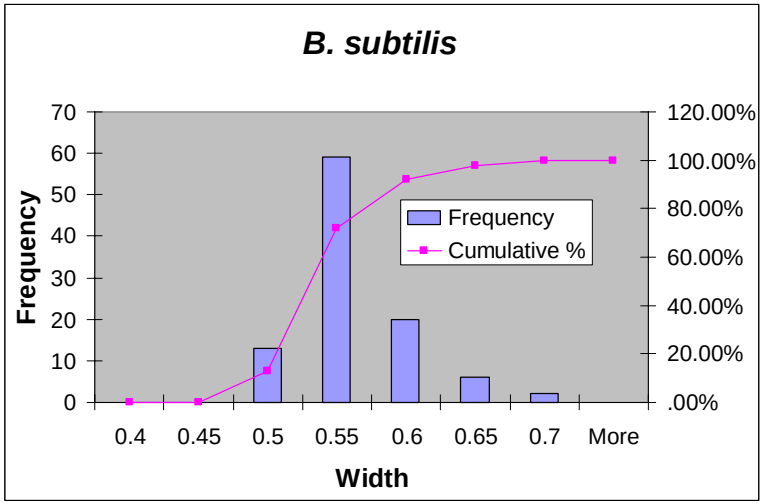
B. subtilis 1031

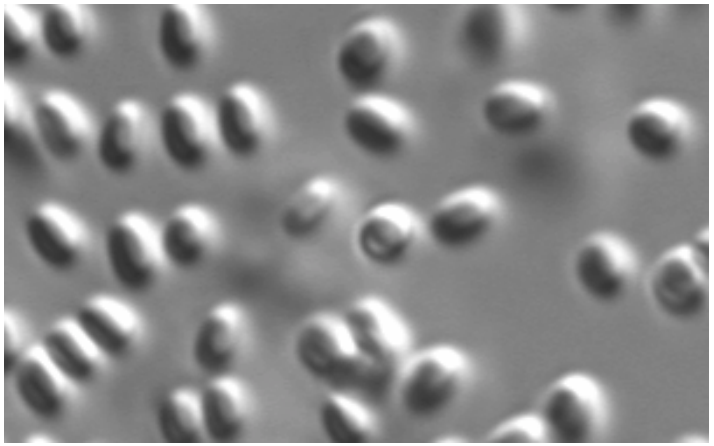


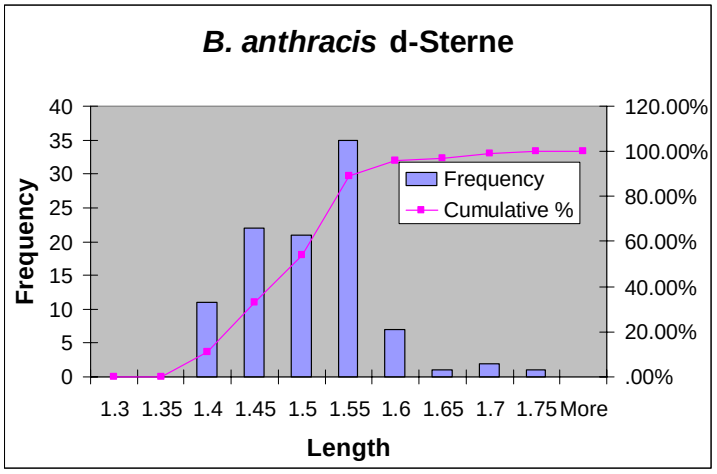


- **Length**
  - **Mean 1.14±0.07 µm**
  - **Range 1.04-1.28 µm**
- **Width**
  - **Mean 0.54±0.04 µm**
  - **Range 0.46-0.69 µm**

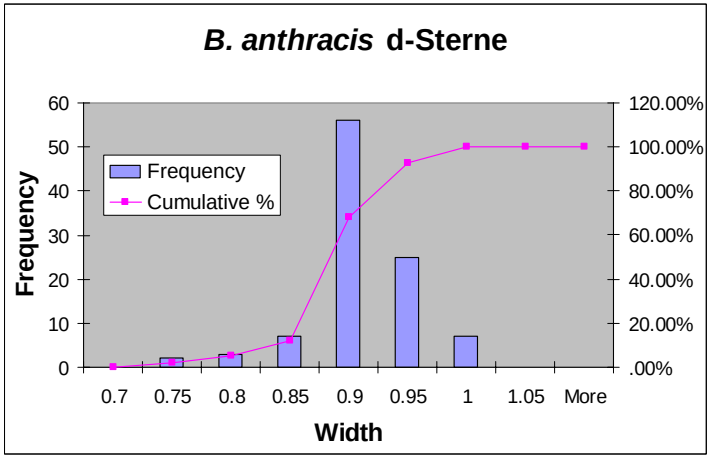


B. anthracis (Δ-Sterne)





- **Length**
  - **Mean 1.48±0.07 µm**
  - **Range 1.37-1.71 µm**
- **Width**
  - **Mean 0.89±0.05 µm**
  - **Range 0.75-1.00 µm**



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Comparison of Measurements by TEM vs. OM

		Length	Width
B. globigii	TEM	1.22 +/- 0.12	0.65 +/- 0.05
	OM	1.27 +/- 0.10	0.67 +/- 0.07
B. subtilis	TEM	1.07 +/- 0.09	0.48 +/- 0.03
	OM	1.14 +/- 0.07	0.54 +/- 0.04
B. anthracis (d-Sterne)	TEM	1.56 +/- 0.16	0.82 +/- 0.06
	OM	1.48 +/- 0.07	0.89 +/- 0.05

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CONCLUSIONS

- **Systematic comparison of spore properties of several Bacillus species.**

- **Compared spore size properties of 6 species of Bacillus by TEM.**

- ***B. anthracis* spores are significantly larger than spores of the most common simulants, *B. g.* and *B. subtilis*.**

- ***B. anthracis* spores are similar in size to *B. cereus* and *B. megaterium*.**

- **Spores of pathogenic and non-pathogenic *B. anthracis* are similar in size.**

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